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ESTIMATING A FISCAL REACTION FUNCTION: THE CASE OF DEBT SUSTAINABILITY IN BRAZIL

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ESTIMATING A FISCAL REACTION FUNCTION: THE CASE OF DEBT SUSTAINABILITY IN BRAZIL

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Abstract

This paper reviews recent trends in fiscal performance in Brazil, estimates fiscal reaction functions for the consolidated public sector and different levels of government, and tests for the sustainability of the public debt dynamics. The empirical analysis, based on monthly data for the period 1995-2004, suggests that all levels of government react strongly to changes in indebtedness by adjusting their primary budget surplus targets. In addition, the central government appears to follow a spend-and-tax policy: changes in revenue are affected strongly by expenditure. About two-thirds of changes in primary spending are offset by higher revenue over the longer term. Institutions are also found to matter for fiscal sustainability. The responsiveness of the sub-national fiscal stance to indebtedness, as well as that of central government revenue to changes in primary spending, appears to become stronger after 1998, when ceilings on indebtedness were introduced.

JEL classification numbers: E62, H62, H63.

Keywords: Brazil, fiscal reaction function, debt sustainability, fiscal rules.

1. Introduction

Brazil's fiscal adjustment over the past few years has been impressive. Since the floating of the *real* in 1999, fiscal policy has responded forcefully to changes in the macroeconomic environment, and the consolidated public sector's primary surplus targets has been raised over time to keep the debt-to-GDP ratio on a sustainable path. Fiscal performance has been strong even when economic activity has slowed down, making the fiscal effort all the more impressive. The consolidated primary surplus target was raised further in mid-2004 to save part of the cyclical revenue windfall while accommodating some additional spending in much-needed infrastructure investment. These developments are in contrast with the early period of macroeconomic adjustment during 1995-98, where monetary reform in mid-1994 brought inflation down and exposed budgetary imbalances that could previously be financed through seignorage. The country's strong fiscal performance owes much to a comprehensive overhaul of institutions, including the introduction of ceilings on indebtedness and on personnel spending during 1995-98 and the enactment of the Fiscal Responsibility Law in 2000.

However, while fiscal adjustment has been instrumental in ensuring the sustainability of the public debt dynamics, it has been achieved predominantly by hiking revenue and cutting back public investment, rather than retrenching current expenditure. These developments cast doubt over the quality of fiscal adjustment, a problem which will need to be addressed in the years to come. Against this background, this paper estimates a fiscal reaction function for Brazil over the period 1995-2004. In doing so, it is possible to

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gauge the extent to which the primary budget balance tends to be adjusted in response to changes in public indebtedness. Conventional cointegration-based tests are also used to assess whether the public debt dynamics is sustainable. Different options are considered to deal with seasonality in the budget, given the use of monthly data in the empirical analysis, and the effect of seasonal adjustment on the accuracy of unit root and cointegration tests.

The main findings of the paper are that, first, all levels of government (the consolidated public sector, as well as the central government and the regional governments, separately) have responded to rising indebtedness by increasing their primary budget surpluses; second, the fiscal reaction function is affected by institutions, particularly the introduction of ceilings on indebtedness at the regional government (states and municipalities) level in 1998; and, finally, the public debt dynamics is sustainable but, whereas central government revenue responds strongly to changes in spending, the converse does not appear to be true, characterising a spend-and-tax policy.

The paper is structured as follows. The next section describes recent trends in fiscal performance. Section 3 reports the empirical findings for the estimation of a fiscal reaction function. Section 4 discusses debt sustainability. Section 5 concludes.

2. Recent trends in fiscal performance

It has become customary to describe fiscal performance in Brazil since the early 1990s as a three-period process.[2] The turning points broadly coincide with monetary reform in May-July 1994, characterised by the introduction of a new currency -- the *real* -- in July 1994, and the abandonment of the exchange rate peg in January 1999.[3]

The period following the floating of the *real* in January 1999 has been marked, by and large, by fiscal conservatism (Figure 1). In an effort to stabilize the public debt-to-GDP ratio, the consolidated public sector -- including the central government, the social security system, the central bank, the regional governments (states and municipalities) and the public enterprises (all levels of government) -- has posted an average primary surplus of about 3.5 percent of GDP between 1999 and mid-2004. This is in sharp contrast with the average primary deficit of 0.4 percent of GDP during 1996-98. The deterioration of the primary balance was particularly pronounced following monetary reform in May-July 1994, when the reduction of inflation reduced the scope for deficit financing through seignorage and the erosion of the real value of expenditure. Fiscal effort after 1999 has also been shared across the different levels of government. In the early 1990s, the central government was responsible for more than one-half of the average primary surpluses of the consolidated public sector and sub-national finances were in persistent disarray. During the period 1995-98, the regional governments (states and municipalities) posted the worst primary balances of all three levels of government.

Consistent with higher primary surpluses, the nominal (headline) consolidated budget balance also improved in the post-1999 period. But it remains volatile, due to the preponderance in the public debt stock of securities paying floating interest rates, which makes fiscal stance overly sensitive to changes in market sentiment. Although nominal deficits declined after 1994 with disinflation, the operational deficit -- which accounts for interest payments measured in real, rather than nominal, terms – trended upwards, chiefly in

2 . See Giambiagi and Ronci (2004), for example, for more information and Tanner and Ramos (2003) for an empirical analysis of fiscal dominance in the post-stabilisation period.

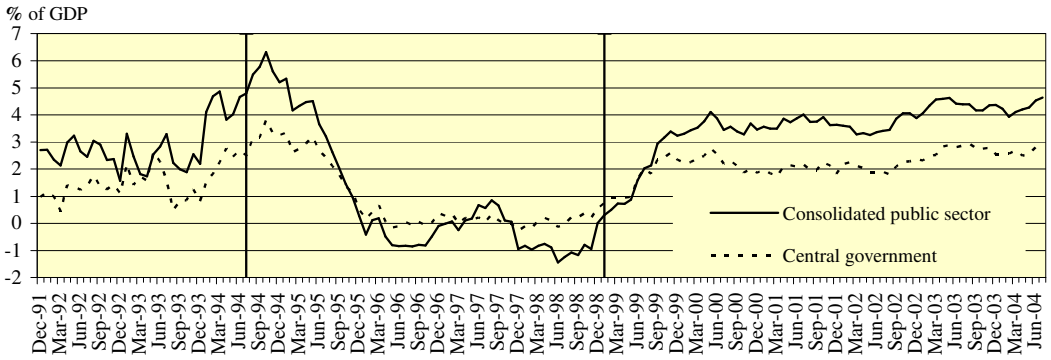
3 . This is confirmed by more rigorous testing. Using a Markov chain process to describe the behaviour of the primary balance, Rocha and Picchetti (2003) identify a regime change in 1995 (moving from a period of contraction to expansion) and in 1999 (moving from expansion to contraction).

line with the tight monetary stance pursued after monetary reform and the lower primary surpluses posted until 1999.

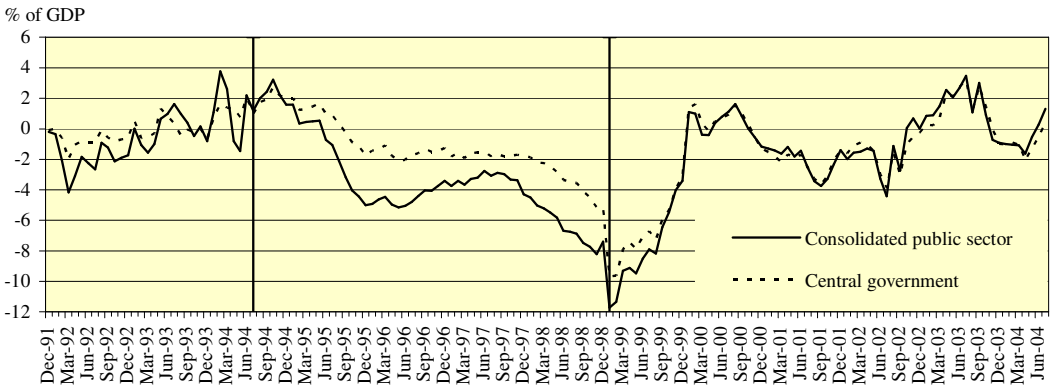
Figure 1. Budget outturn, 1991-2004

Cumulative 12-month flows (a positive sign indicates a budget surplus)

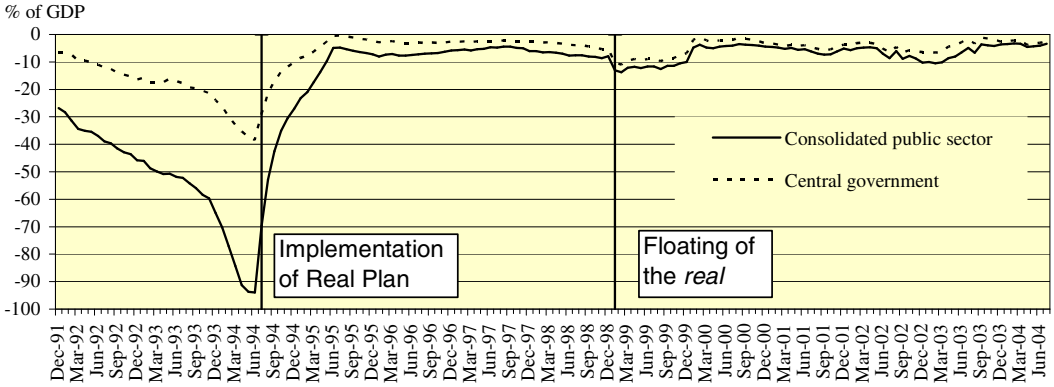
A. Primary balance



B. Operational balance



C. Nominal balance



Source: Central Bank of Brazil.

Two main features of the post-1999 fiscal consolidation can be highlighted. First, the fiscal stance, measured by the primary budget balance, appears to have become more sensitive to changes in public indebtedness (Figure 2). Nevertheless, despite progress in fiscal consolidation and improvements in public debt management, indebtedness remains a source of vulnerability. On occasions of fiscal stress, public debt management has aimed at reducing rollover risks through the issuance of shorter-tenor securities. It has also responded to growing demand for foreign exchange hedge by issuing foreign exchange-indexed securities and foreign exchange swaps, thereby increasing the government's foreign exchange exposure. Acceptance of a deterioration of the public debt indicators in conditions of financial stress is often predicated on the assessment that market dislocations on such occasions are predominantly technical and transitory. When financial conditions have been favourable, public debt management has aimed at reducing foreign exchange exposure, lengthening maturities and replacing floating- by fixed-rate securities. Exposure to foreign exchange risk has been reduced considerably since 2003 due to the gradual retirement of foreign exchange-indexed debt.

Second, fiscal consolidation has been achieved predominantly through revenue hikes and, to a lesser extent, a compression of discretionary spending, particularly on investment programmes, rather than cuts in current outlays. To illustrate, the consolidated revenue ratio increased by about 7 percentage points during 1995-2003 to nearly 35 per cent of GDP, while federal investment was reduced by 0.2 percentage points in the period, to about 0.4 per cent of GDP in 2003, having recovered somewhat in 2004. Failure to retrench current spending is due in part to downward rigidities in the budget, deriving to a large extent from the extensive earmarking of revenue. The introduction of spending floors for several programmes over the years, including health care and education, has also exacerbated budget inflexibility. At the same time, social security pressures have mounted and the creation of new expenditure commitments, particularly in old age-related assistance, has put additional upward pressure on current spending. These developments are at odds with the experience of OECD countries, which suggests that fiscal consolidation is more likely to be successful -- at least to the extent that it leads to a sustainable reduction in indebtedness -- when based on the retrenchment of current spending rather than investment cuts and revenue hikes.

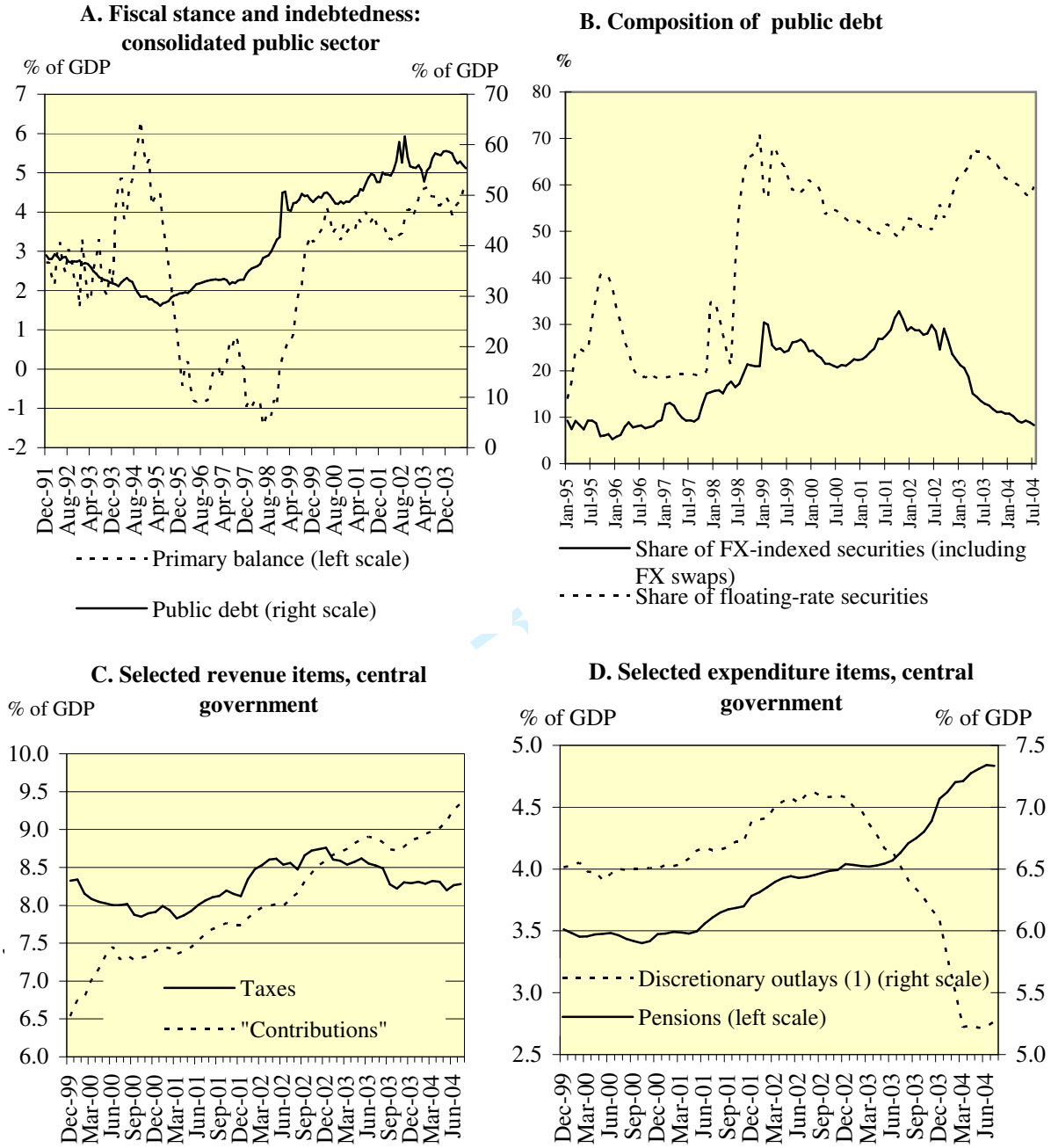
Fiscal consolidation underpinned by tax hikes has had a detrimental impact on the efficiency of the tax system. While central government tax revenue has been broadly stable in relation to GDP since end-1999, that of federal "contributions" (*i.e.,* levies whose revenue is earmarked for specific programmes, particularly in the social sectors, but not shared with the regional governments) has risen steadily. Originally levied on enterprise turnover and payroll, reliance on these federal contributions has had a detrimental impact on Brazil's trade competitiveness. The main federal contributions have now been converted into value added-type taxes, somewhat mitigating this problem. However, regional government revenue has also trended upwards, consistent with their own fiscal consolidation efforts.[4] This increase in the tax take needs to be evaluated against the fact that Brazil already has a high revenue-to-GDP ratio in comparison with countries of comparable income levels, being close to the OECD average and nearly twice as high as that of Latin America.[5]

4 . The increase in state-level revenue was also facilitated by rising utility and energy prices, which are taxed heavily by the states.

5 . See OECD (2005), for more information.

Figure 2. Fiscal stance and indebtedness, 1991-2004

Cumulative 12-month flows



Source: Central Bank of Brazil and IPEA.

1. Measured as "other current and capital spending" (other OCCs).

3. Estimating a fiscal reaction function

3.1. Estimating equation

The main hypothesis to be tested when estimating a fiscal reaction function is that the government adjusts the primary budget balance in response to changes in indebtedness so as to ensure the sustainability of the debt dynamics over time. Following the empirical literature (*e.g.*, Bohn, 1998; Gali and Perotti, 2003), the specification of fiscal reaction function is based on the government's intertemporal budget constraint:

$$b_t + (r_t - g_t)d_{t-1} = \Delta d_t + \Delta m_t + (\pi_t + g_t)m_{t-1}, \quad (1)$$

where $b_t = \tau_t - \gamma_t$ is the ratio of primary budget surplus to GDP (with τ_t denoting revenue and γ_t, primary expenditure, both in relation to GDP), $r_t = i_t - \pi_t$ is the real interest rate (with i_t defining the nominal interest rate and π_t, inflation), g_t is the real rate of GDP growth, d_t is the debt-to-GDP ratio, and m_t is monetary base-to-GDP ratio (t is a time index and Δ is the difference operator).

Assuming for algebraic simplicity that $\Delta m_t = 0$ (*i.e.,* no monetary financing of budget imbalances) and $r_t \leq g_t$, it then follows from Equation (1) that, for every time period, the share of the primary surplus in GDP can be calculated to keep the debt-to-GDP ratio constant according to $b_t = \frac{r_t - g_t}{1+g_t} d_{t-1}$. When fiscal policy is carried out over an infinite time horizon, the share in GDP of the present value of the primary surplus can be calculated to equate the debt-to-GDP ratio, such that $d_{t-1} = \sum_{j=0}^{\infty} \frac{B_{t+j}}{(1+r)^{j+1} Y_{t-1}}$, which is independent of the rate of growth of GDP. Equation (1) can be solved forward subject to a no-Ponzi-game transversality condition ($\lim_{T\to\infty} \frac{d_{t+T+1}}{(1+r)^{t+T}} = 0$) on the optimal behaviour of lenders. In other words, the current debt stock should be equal to the sum of expected future discounted primary budget surpluses. The fiscal reaction function can therefore be estimated by regressing the primary budget surplus on the public debt, both defined in per cent of GDP, while controlling for other determinants of the fiscal stance. In particular:

$$b_i(t) = a_0 + a_1 b_i(t-1) + a_2 d_i(t-1) + a_3 C_i(t) + u_i, \quad (2)$$

where C is a set of control variables for level of government i at time t.

The main parameter of interest in Equation (2) is a_2, which is expected to be positively signed, indicating that an increase in the public debt ratio is associated with an increase in the primary budget surplus. Standard controls include the output gap, to capture the impact of the business cycle on the budget, depending on the size of automatic stabilizers, and inflation, to account for shocks to seigniorage revenues.

3.2. Data and unit root tests

Monthly data are available for all variables for the period January 1995 to July 2004 from the Central Bank of Brazil (BCB). The nominal budget balance (public sector borrowing requirement, PSBR) is calculated as the change in the public debt stock in the reference period (excluding stock adjustments),

which is in turn calculated on the basis of the financial sector's total claims on the public sector and the central bank's external debt register. Interest payments on the external debt and the foreign exchange-indexed/denominated domestic debt are calculated on an accrual basis.[6] The primary balances of all levels of government are calculated by the BCB from below the line as a residual once the operational balance is subtracted from the nominal balance for each level of government. Appendix Table 1 reports the definitions and sources of the data used in the empirical analysis.

An important question is how to deal with seasonality in the budget. The preferred option is to seasonally adjust the data by accumulating the monthly series over 12-month periods, but some attempt will also be made to use the seasonally unadjusted series because seasonal adjustment biases the outcome of the unit root tests towards accepting the null of unit roots. Ignoring seasonal unit roots also adversely affects the consistency of the coefficients in cointegration regressions (reported below). To assess the unit root properties of the data, three tests were performed for the seasonally adjusted series: the ADF, the Phillips-Perron (PP) and the Zivot-Andrews (1992) tests.[7] For the seasonally unadjusted data, the Hylleberg *et al.* (1990) (HEGY) test was used. A caveat to consider when interpreting the results of the unit root tests is that the time span for which information is currently available is relatively short. It is well known that unit root tests have stronger predictive power when data are available for longer time periods.

The results of the unit roots tests for central government expenditure and revenue are reported in Appendix Table 2. The lag length used to whiten the residuals was chosen on the basis of the Schwarz Bayesian information criterion (BIC). The regressions feature a constant term and a linear trend. On the basis of all three tests, both the expenditure and revenue data appear to have unit root when the variables are defined in levels. The public debt ratio and inflation were found to follow I(1) processes in levels whereas the output gap was found to be I(0) in levels (results not reported).

A final set of tests was applied to the seasonally unadjusted data to test for the presence of seasonal unit roots. Although the HEGY test applies to quarterly data, it was subsequently extended to monthly data by Beaulieu and Miron (1993), among others. The estimates of all the roots of the time-series representation (π_1 to π_{12}) are reported in Appendix Table 3, together with the joint F-tests for $\pi_i = \pi_{i+1} = 0$. The results suggest that the non-rejection of $\pi_1 = 0$ for primary spending and revenue confirm the presence of a non-seasonal unit root in the data, but not for total spending. The hypothesis of seasonal unit roots is rejected at the $\pi/2$ and $2\pi/3$ frequencies for primary spending and total spending and for all series at the $\pi/6$ frequency.

3.3. Baseline results and the role of institutions

Estimation of the fiscal reaction function suggests that there is a positive, strong reaction of the consolidated primary surplus to changes in indebtedness (Table 1). An increase in net indebtedness by 1 per cent of GDP is associated with an increase in the primary surplus of 0.03 per cent of GDP accumulated over a 12-month period. Sub-national fiscal stance, measured by the primary balance of the regional governments, does not seem to affect the budget balance of the central government at classical levels of

[6] The PSBR no longer includes the valuation changes in the stock of domestic foreign exchange-indexed debt accrued, but not paid in the reference period, due to exchange rate movements.

[7] The main advantage of the Zivot-Andrews test over the ADF test is that it allows for the possibility of a one-off structural change under the alternative hypothesis and that the timing of this structural break does not need to be known *a priori*. The date of a structural break is estimated from the data as the observation that maximizes the absolute value of the unit root statistic. This is important because of the numerous changes in Brazil's exchange rate regime, which may have a bearing on fiscal policy, causing a regime shift in the data generating process.

significance. With regard to the control variables, the output gap is positively signed at all levels of government, suggesting that a cyclical downturn is associated with a lower primary balance, but the parameter estimate is barely significant at the 10 per cent level for the consolidated public sector. This provides preliminary evidence that fiscal stance is acyclical in Brazil. The baseline results are by and large robust to the replacement of the net debt stock by interest payments, also defined in per cent of GDP. Estimating Equation (2) by 2SLS yields comparable results (not reported).

There is a large literature, pioneered by Eichengreen and Bayoumi (1994) and Bohn and Inman (1996), among others, on the relationship between budget institutions and fiscal outcomes, including in Latin America (Alesina *et al.*, 1999). To assess the impact the enactment of the Fiscal Responsibility Law (LRF) in 2000 -- which sets a general framework for budgetary planning and execution applicable to all levels of government -- may have had on the government's fiscal reaction function, a dummy variable, taking the value of "1" for the period after May 2000, and "0" otherwise, identifying the post-LRF period, was interacted with the public debt ratio. The results, also reported in Table 1, suggest that the fiscal stance became somewhat less responsive to indebtedness in the post-LRF period at the consolidated public sector and central government levels. This finding is counter-intuitive and may be attributed to the fact that most of the LRF-induced stabilisation may have taken place prior to the actual enactment of legislation, including as a result of specific legislation setting ceilings on debt and personnel spending, and that the post-2000 period was characterised by considerable macroeconomic volatility.

To shed further light on this hypothesis, an alternative interaction term was experimented with, defined for a dummy variable taking the value of "1" for the period after August 1998, and "0" otherwise, when ceilings on indebtedness were introduced for the regional governments by the Senate.[8] The empirical findings suggest that, whereas in the period prior to the issuance of the Senate Resolution introducing the debt ceilings the reaction function of the regional governments was not responsive to indebtedness, this does not appear to be the case thereafter.

The empirical findings are broadly robust to the replacement of indebtedness by government outlays on personnel. This is because different pieces of legislation were introduced over the years, starting in 1995, setting ceilings on government outlays on personnel as an integral part of fiscal consolidation. The baseline results for the central government are also robust to the estimation of the regressions treating the fiscal stance of regional governments as endogenous.

[8] It is important to bear in mind that debt ceilings have also been proposed for the central government, but legislation is yet to be approved.

Table 1. Fiscal reaction functions, 1995-2004[a]

Dep. Var.: Primary budget balance in per cent of GDP

	Consolidated public sector			Central government			Regional governments		
	Baseline	1	2	Baseline	1	2	Baseline	1	2
Primary balance (lagged)	0.90 ***	0.92 ***	0.90 ***	0.89 ***	0.85 ***	0.88 ***	0.85 ***	0.85 ***	0.82 ***
	(0.018)	(0.020)	(0.019)	(0.043)	(0.043)	(0.045)	(0.048)	(0.048)	(0.050)
Indebtedness (lagged)	0.03 ***	0.03 ***	0.01	0.02 ***	0.02 ***	0.00	0.03 ***	0.03 ***	0.00
	(0.006)	(0.006)	(0.014)	(0.005)	(0.005)	(0.013)	(0.009)	(0.009)	(0.017)
Indebtedness (lagged) * Post-LRF period[b]		-0.01 **			-0.01 ***			0.00	
		(0.002)			(0.003)			(0.003)	
Indebtedness (lagged) * Post-Senate Res. period[b]			0.01			0.01			0.01 **
			(0.005)			(0.006)			(0.004)
Output gap (lagged)	0.02	0.02 **	0.02 *	0.01	0.01	0.01	0.00	0.00	0.00
	(0.010)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)	(0.004)	(0.004)	(0.004)
Inflation (lagged)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Primary surplus (regional governments)[c]				0.01	0.11	0.01	0.06		
				(0.128)	(0.127)	(0.128)	(0.048)		
Primary surplus (public enterprises)[c]				0.01	0.12	0.03	0.001	0.07	0.09 *
				(0.105)	(0.106)	(0.105)	(0.002)	(0.051)	(0.050)
Adjusted R-squared	0.98	0.96	0.98	0.96	0.96	0.96	0.97	0.97	0.97

a. All equations have been estimated by OLS and contain an intercept (not reported). Standard errors are reported in parentheses. Statistical significance at the 1, 5, and 10 per cent levels is indicated by, respectively, ***, **, and *. The sample spans the period January 1995 to July 2004 (114 observations).

b. "Post-LRF period" ("Post-Senate Res. Period") is a dummy variable taking the value of "1" for the period after May 2000 (after August 1998) and "0" otherwise.

c. "Regional governments" refers to the states and municipalities and "public enterprises" refers to all levels of government.

4. Debt sustainability and revenue/expenditure responsiveness

4.1. Baseline results

The results presented above can be refined to shed further light on debt sustainability. To this end, attention is focused on the central government to estimate the responsiveness of expenditure and revenue to changes in indebtedness, and to assess whether this responsiveness has been affected by the enactment of the Fiscal Responsibility legislation. Monthly above-the-line data on primary revenue and expenditure are available from the National Treasury for the central government, including the federal government, the central bank and the social security system. Below-the-line data on interest payment are available for the central government from the BCB, allowing for the calculation of total expenditure, including interest payment. Data constraints prevent the analysis for the consolidated public sector and for the regional governments, separately.

The empirical literature, pioneered by Hamilton and Flavin (1986), focuses on testing the debt sustainability hypothesis by assessing the stationarity properties of the budget balance and the cointegration properties of the revenue and expenditure series. In general, the empirical literature using U.S. data fails to support the sustainability hypothesis when the discount rate is time-invariant. Using U.S. data in the period 1950-88, and assuming a constant real discount rate, Hakkio and Rush (1991) cannot accept the hypothesis of cointegration between spending (including interest payment) and revenue in the post-1964 period, although both series are found to have unit roots. These findings are consistent with those reported by Trehan and Walsh (1988, 1991), who fail to accept the hypothesis that the debt is sustainable, despite the stationarity of the primary balance. On the other hand, if the real rate of interest is not constant but positive, Trehan and Walsh (1991) accept the sustainability hypothesis using U.S. data for 1960-84 on the grounds that the overall deficit (including interest payment) is stationary. Likewise, using longer data series for the United States and United Kingdom, Ahmed and Rogers (1995) decompose the primary balance into revenue and primary spending, as Hakkio and Rush (1991), and show that revenue, primary spending, and real interest payments cointegrate, thereby lending support to the sustainability hypothesis. Evidence for other countries is more limited, with the exception of Corsetti and Roubini (1991) for a sample of OECD countries

There is a growing literature on debt sustainability in Brazil. Issler and Lima (2000) tests the sustainability hypothesis using cointegration-based tests in the spirit of the empirical analysis reported below using annual data for 1947-92. More recent estimates reported by Bicalho (2005), based on monthly data for the period 1997:12-2004:7, also support the sustainability hypothesis. The unit root-based tests reported by Giambiagi and Ronci (2004) for the period 1995-2002 fail to support the stationarity hypothesis for the discounted, rather than undiscounted, public debt. In a different strand of literature, Garcia and Rigobon (2004) assess the stochastic properties of the Brazilian public debt dynamics and find evidence in favour of sustainability in the absence of risk. The debt dynamics is also found to be affected by the spreads on sovereign foreign exchange-denominated debt. Pires and Bugarin (2003) focus on sub-national indebtedness and report unit root tests for revenue and expenditure at the state level, suggesting that revenue is stationary, but not expenditure, which implies a deficit bias at the regional government level.

Conventional tests suggest that the public debt dynamics is sustainable in Brazil. On the basis of unit root tests, the nominal budget balance (including interest payment), revenue, primary expenditure, and total expenditure (including nominal interest payments) follow I(1) processes, being stationary in levels. In addition, cointegration tests were performed for central government expenditure (G) and revenue (T), such that a system $X = (G,T)$ can be written in error-correction form:

$$A(L)\Delta X_t = \Pi X_{t-1} + u_t, \qquad (3)$$

where, as usual in its restricted form, $\Pi = \alpha\beta'$, β' is the vector of cointegrating coefficients, α is the vector of loading coefficients, $A(L)$ is the distributed lag operator, and u_t is a multivariate white-noise process.

Based on the Johansen-Juselius multiple cointegrating vector (FIML) methodology, expenditure (with and without interest payments) and revenue appear to cointegrate (Table 2).[9] This suggests that there is a stable long-run relationship between the GDP shares of the primary balance and the lagged debt stock, satisfying the necessary condition for debt sustainability.[10] The point estimate of the cointegrating vector is (1, -1.06) (normalization on expenditure) when total spending is used and (1, -0.88), when only primary expenditure (excluding nominal interest payments) is considered. The restriction that the coefficients of the cointegrating vector are (1,-1) cannot be rejected at classical levels for the overall budget balance, but not for the primary balance. Because the period of analysis is characterised by low inflation, at least by Brazilian standards, the results are not sensitive to the use of real or nominal interest payments.

To shed further light on the robustness of the results, the cointegration vector was also estimated by the DOLS methodology (Stock and Watson, 1993), which has the advantage that the endogeneity of the regressors does not affect the robustness of the estimates, being equivalent asymptotically to Johansen's MLE method (Johansen, 1988). It performs well in finite samples. The results, also reported in Table 2, suggest that the estimated coefficients for government revenue are somewhat lower than when estimated by the Johansen-Juselius method. Given that the time series are short, it is not possible to test for seasonal cointegration, using for example the maximum likelihood estimator proposed by Johansen and Schaumburg (1999), given that the relevant series appear to have seasonal unit roots. Nevertheless, an additional robustness check was carried out by re-estimating the cointegrating vectors by DOLS using the seasonally unadjusted data and including seasonal dummies in the regressions as an attempt to model deterministic, but not stochastic, seasonality. The results suggest greater robustness in the case of primary spending than total expenditure. While the seasonal dummies (not reported) were found to be statistically significant in the model for primary central government spending, this was not the case for that including total expenditure.

Because a stable long-run relationship can be shown to exist between the central government expenditure and revenue in the VAR defined by Equation (3), where $0 < r < n$ and r is the rank of Π, exogeneity tests can be carried out in the tradition of Engle, Hendry and Richard (1983) and Johansen (1992, 1995) by imposing a restriction on the loading parameters of the cointegrating vector. The exogeneity tests suggest that expenditure is weakly exogenous for the cointegrating vector, regardless of whether interest payments are taken into account, but revenue is not. This implies that the central government follows a spend-and-tax strategy to keep the debt dynamics sustainable. These findings are consistent with those reported by Issler and Lima (2000), who report VECM estimations for the period

9 . The lag length was selected using a variety of information criteria including Schwarz, Hannan-Quinn, and Akaike, and the trace statistic was corrected for small sample bias. Because the cointegration tests using this technique are sensitive to the choice of the deterministic elements of the VAR, a likelihood ratio test was used to ascertain the appropriateness of including a constant and seasonal dummies in the VAR. The model without time dummies, but with a constant, usually performed better than that without a constant.

10 . If the overall budget balance is stationary but expenditure and revenue do not cointegrate, sustainability is ensured but the deficit process is inconsistent with a constant expected real rate of interest. The literature also deals with the possibility of time-varying discount rates, following Bohn (1995), in a stochastic environment with uncertainty, on the grounds that the relevant discount rate for the purpose of debt sustainability is a function of the contingent probability of future debt and the intertemporal rate of substitution in consumption.

1947-92 using national accounts data and suggesting that the budget in Brazil is balanced almost entirely through changes in revenue, regardless of how the initial imbalance was generated.

Table 2. Debt sustainability: Cointegration tests, 1998-2004[a]

Dep. Vars.: Central government revenue and expenditure

	Primary expenditure		Total expenditure (includes nominal interest payments)	
	Eigenvalue	Trace	Eigenvalue	Trace
Cointegration tests				
H0: rank = p				
p == 0	0.16	14.57 **	0.15	12.12 **
p <= 1	0.03	2.14	0.07	5.24 **
Lag interval	1 to 5		1 to 6	
Deterministic component	No		No	
Cointegration vectors				
Normalized vector (on expenditure)				
Johansen-Juselius method	(1,-0.88)		(1,-1.06)	
Restriction test: Ho: (1,-1)[b]	8.82		0.40	
	[0.00]		[0.53]	
Weak exogeneity tests:[c]				
Expenditure is exogenous: Ho: (0,a)	0.16		1.42	
	[0.69]		[0.23]	
Revenue is exogenous: Ho: (*a*,0)	10.02		4.28	
	[0.00]		[0.04]	
Cointegration vectors (normalized on expenditure): Robustness checks				
DOLS[d] method with seasonally adjusted data	0.61***		0.77 ***	
DOLS[d] with seasonally unadjusted data and seasonal dummies	0.40 ***		0.45	

Source: Data available from the Central Bank of Brazil, and author's estimations.

a. Refers to the Johansen-Juselius cointegration tests. (***) and (**) indicate statistical significance at the 1 percent and 5 percent levels, respectively. The sample spans the period January 1998 to July 2004 (78 observations) or January 1997 to July 2004 (90 observations) when the seasonally unadjusted series are used.

b. Disctributed as chi-squared, with 1 degree of freedom (*p*-values in brackets).

c. Based on the estimated cointegrating vector of rank equal to one and distributed as chi-squared, with 1 degree of freedom (p-values in brackets).

d. Based on the OLS estimation of the following equation:

$G_t = a_0 + a_1 R_t + a_2 \sum_{i=1,2} \Delta G_{t+i} + a_3 \sum_{i=1,2} \Delta G_{t-i} + a_4 \sum_{i=1,2} \Delta R_{t-i} + a_5 \sum_{i=1,2} \Delta R_{t-i} + u_t$, where *G* and *R* denote, respectively, government expenditure and revenue. The number reported is a_1.

4.2. Error-correction representation

On the grounds that expenditure seems to be weakly exogenous, an error-correction representation of the fiscal reaction function can now be used to assess the short-term response of fiscal policy mix to indebtedness, taking other determinants of the fiscal stance into account. The findings, reported in Table 3, suggest that changes in revenue are affected strongly by expenditure: about two-thirds of changes in primary spending are offset by higher revenue over the long term. The long-run response of revenue to total expenditure (including interest payments) is much lower, at about 15 per cent.[11] In comparison with the results reported in Table 1, the output gap remains insignificant at classical levels but inflation now appears to have a statistically significant, albeit small, effect on revenue over the long term. The fiscal stance of the regional governments now seems to affect revenue at the central government level, at least in the short run, suggesting that the central government may compensate for weaker budget outturns at the sub-national level by increasing its own fiscal effort. Moreover, the error-correction results lend further support to the hypothesis that institutions affect the government's fiscal reaction function. The responsiveness of revenue to changes in primary spending appears to have increased, albeit by a small magnitude, after the issuance in 1998 of legislation setting ceilings on indebtedness.

In so far as the effect of regional government finances on the fiscal stance of the central government and the role of institutions are concerned, the findings of the error-correction estimations, while interesting, are not robust to the inclusion of interest payments in central government expenditure. This is nevertheless not surprising, given the volatility of nominal interest payments in Brazil, which reflects, as discussed above, the composition of the public debt stock and, consequently, the sensitivity of debt dynamics to changes in market conditions.

5. Conclusions

This paper reviewed trends in fiscal performance in Brazil since the early 1990s, reported empirical findings on the estimation of a fiscal reaction function for the consolidated public sector, as well as the central and regional governments separately, and assessed the sustainability of the public debt dynamics using standard unit root and cointegration tests. Some attempt is made to deal with seasonality in the budget by considering both seasonally adjusted and unadjusted series on account of the effect seasonal adjustment has on the accuracy of unit root and cointegration tests. Of course, due to the short sample for which information is currently available, and given the constraints imposed on hypothesis testing by seasonality in the fiscal data, the empirical findings should be interpreted as indicative, rather than conclusive that, first, all levels of government react strongly to changes in indebtedness by adjusting their primary surplus targets; second, this reaction to indebtedness has been strengthened at the sub-national level through the introduction of debt-constraining legislation in 1998; and, finally, the debt dynamics appears to be sustainable, with the central government following a spend-and-tax policy to ensure debt sustainability: changes in central government revenue are affected strongly by expenditure, with about two-thirds of changes in primary spending being offset through higher revenue over the long term, but the long-term response of revenue to total expenditure (including interest payments) is lower in magnitude, at about 15 per cent.

On the basis of these findings, Brazil will need to continue to post sizeable primary budget surpluses in the years to come to allay concern about the sustainability of the country's public debt dynamics. Only a reduction in the public debt-to-GDP ratio over a prolonged period will mitigate this source of macroeconomic vulnerability, making the economy better equipped to withstand adverse shocks. This should include, at the same time, continued effort to strengthen public debt management, by for example

[11] See Kollias and Makrydakis (2000) for evidence of spend-and-tax behaviour in a sample of European countries.

continuing to improve its composition and thereby reducing government exposure to exchange and short-term interest rate risk.

In addition, while focusing policies on ensuring that the primary surplus targets are met, effort is needed to improve the quality and longer-term sustainability of fiscal consolidation. In particular, a sustained retrenchment in current expenditure would pave the way for reducing the tax burden over the longer-term, once fiscal consolidation has delivered an appreciable fall in indebtedness. Moreover, reducing expenditure rigidities, while avoiding disruption in service delivery in the event of revenue shortfalls, should be a key policy objective in the years to come. More importantly, the merits of continued revenue earmarking and mandated spending should be assessed against the impact these budgetary resources might have on policy outcomes, particularly in the social area.

Table 3. Fiscal reaction functions: Error-correction models, 1997-2004[a]

Dep. Var.: Central government revenue in per cent of GDP

	Primary expenditure		Total expenditure (includes nominal interest payments)	
	1	2	1	2
Change in revenue (lagged)	0.21 *	0.22 *		
	(0.118)	(0.114)		
Revenue (lagged)	-0.34 ***	-0.40 ***	-0.15 **	-0.17 **
	(0.092)	(0.093)	(0.065)	(0.066)
Expenditure (lagged)	0.20 ***	0.24 ***	0.02 **	0.02 **
	(0.069)	(0.069)	(0.012)	(0.012)
Indebtedness (lagged)	0.005	-0.02	-0.001	-0.010
	(0.011)	(0.014)	(0.013)	(0.015)
Indebtedness (lagged) * Post-Senate Resolution period		0.01 **		0.01
		(0.005)		(0.005)
Output gap (lagged)	-0.005	-0.003	0.01	0.01
	(0.009)	(0.009)	(0.009)	(0.005)
Inflation (lagged)	0.01 **	0.01 ***	0.01 **	0.01 **
	(0.003)	(0.003)	(0.003)	(0.003)
Change in primary surplus (regional governments)[b]	-0.42 *	-0.50 **		
	(0.243)	(0.237)		
Primary surplus (regional governments)[b]	0.36 **	0.41 ***	0.14	0.14
	(0.150)	(0.146)	(0.128)	(0.128)
Change in primary surplus (state-owned enterprises)[b]	0.35 **	0.28 *	0.19	0.13
	(0.172)	(0.168)	(0.170)	(0.173)
Adjusted R-squared	0.15	0.21	0.09	0.10
Memorandum item:				
Implied long-term expenditure coefficient	0.59	0.60	0.13	0.12

Source: Data available from the Central Bank of Brazil, and OECD estimations.

a. All equations have been estimated by OLS and contain an intercept (not reported). Standard errors are reported in parentheses. Statistical significance at the 1, 5, and 10 per cent levels is indicated by, respectively, ***, **, and *. The sample spans the period January 1998 to July 2004 (78 observations).

b. "Regional governments" refers to the states and municipalities, and "state-owned enterprises" refers to all levels of government.

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APPENDIX 1: DEFINITIONS, DATA SOURCES AND UNIT ROOT TESTS

Appendix Table 1. Definitions and data sources

Variable	Definition	Source
Primary budget balance	Below-the-line borrowing requirement of each level of government -- consolidated public sector, central government,[a] regional governments (states and municipalities), and state-owned enterprises (all levels of government) -- accumulated over a 12-month period, in per cent of GDP, multiplied by minus one.	Central Bank of Brazil
Public debt stock	End-of-period stock of net liabilities in per cent of GDP.	Central Bank of Brazil
Output gap	Deviation of real GDP from its Hodrick-Prescott (HP)-filtered series.	Central Bank of Brazil
Inflation	Change in IPCA index.	Central Bank of Brazil
Central government primary revenue	Above-the-line flows accumulated over a 12-month period, in per cent of GDP (*pagamento efetivo*).	National Treasury
Central government primary expenditure	Above-the-line flows accumulated over a 12-month period, in per cent of GDP, including intergovernmental transfers (*pagamento efetivo*).	National Treasury
Central government nominal interest payments	Below-the-line flows accumulated over a 12-month period, in per cent of GDP (harmonized methodology).	Central Bank of Brazil

a. The central government comprises the federal government, the social security system and the Central Bank of Brazil.

Appendix Table 2. Unit root tests[a]

	Primary expenditure	Revenue	Total expenditure	Critical value
		ADF tests		
Level	-1.65	-1.93	-2.51	-4.09
First difference	-4.30	-5.15	-4.71	-4.10
		Phillips-Perron (PP) tests		
Level				
Z(rho)	-6.06	-8.47	-10.31	-26.65
Z(t)	-1.80	-2.30	-2.46	-4.09
First difference				
Z(rho)	-79.28	-73.56	-70.30	-26.62
Z(t)	-8.70	-8.56	-7.98	-4.09
		Zivot-Andrews tests		
Level				
Minimum t-statistic	-3.55	-3.12	-3.05	-5.43
Break in:	2001M6	2003M6	2000M1	
First difference				
Minimum t-statistic	-9.29	-8.88	-8.73	-5.43
Break in:	2000M11	2001M6	1999M2	

a. All tests were carried out including 2 lags and a time trend. The critical value is 1% for all tests.

Appendix Table 3. Seasonal unit root tests[a]

Frequency	Roots	Primary expenditure		Revenue		Total expenditure	
0	$t[\pi_1 = 0]$	-2.49		-2.49		-2.99	*
π	$t[\pi_2 = 0]$	-1.33		-2.48	*	-2.52	*
$\pi/2$	$t[\pi_3 = 0]$	-2.51		-2.26		-3.74	*
	$t[\pi_4 = 0]$	0.26		0.45		-0.44	*
$2\pi/3$	$t[\pi_5 = 0]$	-3.22	*	-2.04		-3.43	*
	$t[\pi_6 = 0]$	-0.62		0.75		0.03	*
$\pi/3$	$t[\pi_7 = 0]$	-1.75		-2.36		-3.97	*
	$t[\pi_8 = 0]$	-1		-0.09		0.11	*
$5\pi/6$	$t[\pi_9 = 0]$	-2.44	*	-2.58		-3.72	*
	$t[\pi_{10} = 0]$	0.90		0.43	*	0.25	
$\pi/6$	$t[\pi_{11} = 0]$	-3.22	*	-3.4		-3.56	*
	$t[\pi_{12} = 0]$	-1.46	*	0.53		-0.04	*
$\pi/2$	$F[\pi_3 = \pi_4 = 0]$	3.17	*	2.67		7.17	*
$2\pi/3$	$F[\pi_5 = \pi_6 = 0]$	5.44	*	2.48		5.88	*
$\pi/3$	$F[\pi_7 = \pi_8 = 0]$	2.05		2.79		7.87	*
$5\pi/6$	$F[\pi_9 = \pi_{10} = 0]$	3.55		3.48		6.62	*
$\pi/6$	$F[\pi_{11} = \pi_{12} = 0]$	6.11	*	6.50	*	6.46	*

a. Refers to the Beaulieu and Miron (1993) seasonal unit root tests for monthly time series. An intercept, deterministic trend and seasonal dummies are included. The critical value is 10%.